

Sustainable Alternative Jet Fuels

FAA Overview: R&D Activities and Coordination Efforts

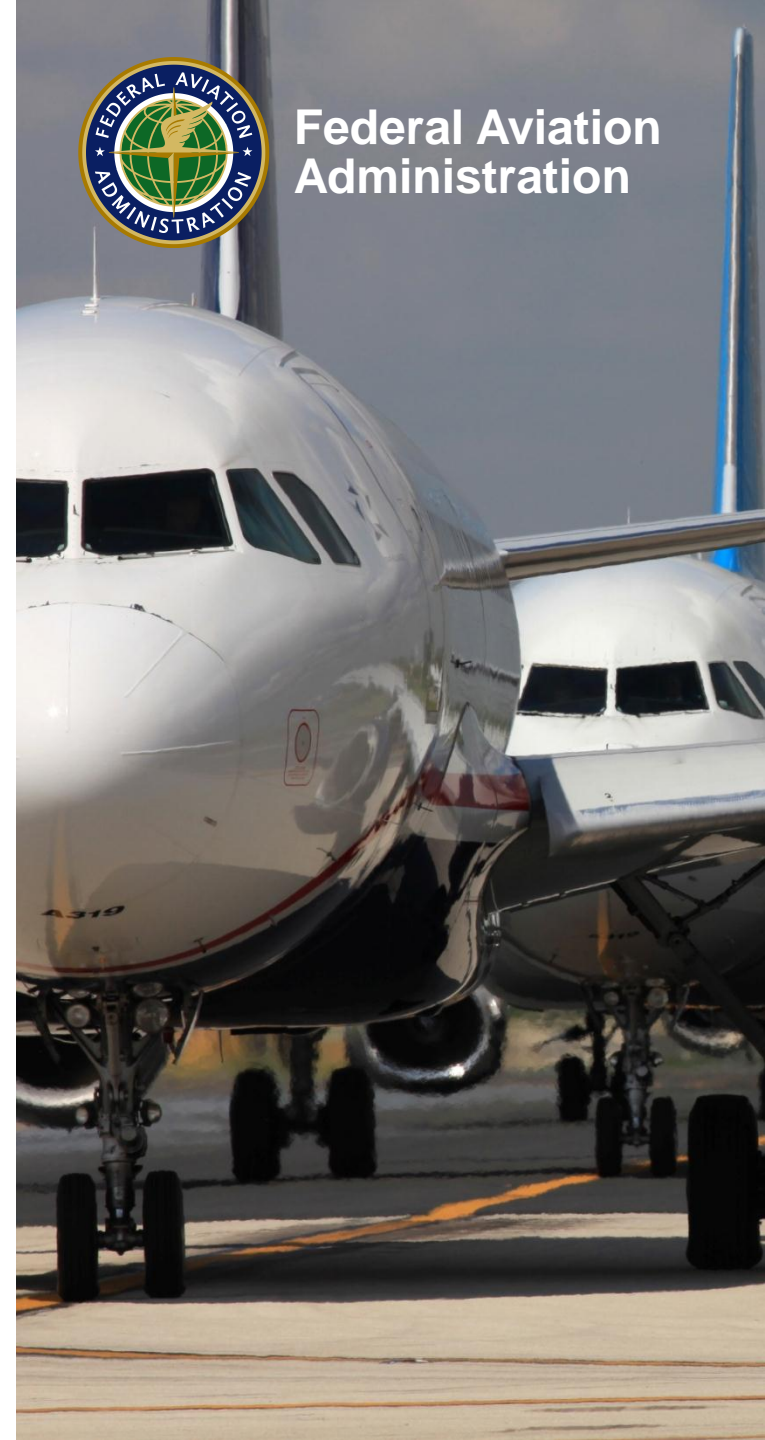
Presented to: ACCESS-2, Public Data Workshop

By: Dr. James I. Hileman
Office of Environment and Energy
Federal Aviation Administration

Date: January 9, 2015



Federal Aviation
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Outline

- **Vision & Approach**
- **FAA Activities**
 - Testing
 - Analysis
 - Coordination
- **Summary**



Aviation Environmental Challenges

NOISE



AIR QUALITY



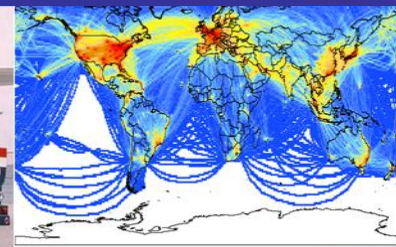
WATER QUALITY



ENERGY



GLOBAL CLIMATE



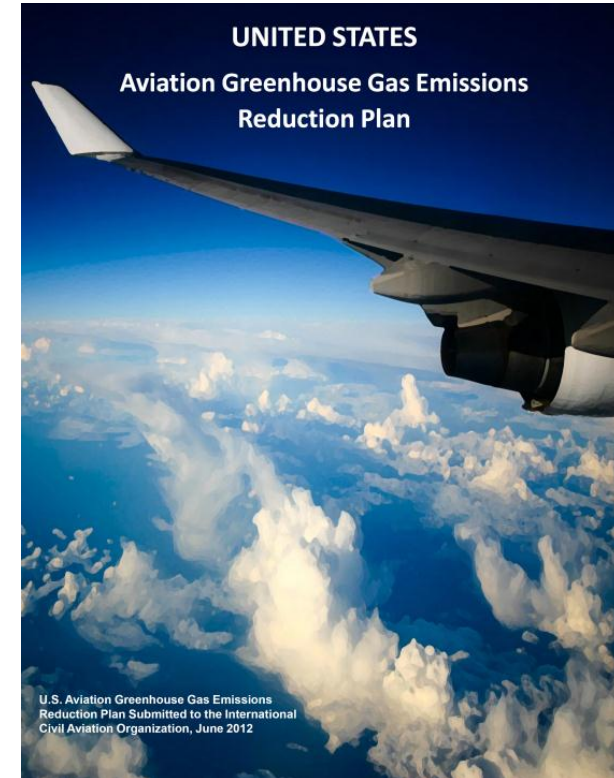
- Aviation impacts community noise, air quality, water quality, energy usage, and climate change
- Environmental impacts from aviation emissions could pose a critical constraint on capacity growth
- Alternative jet fuels could reduce the environmental impact of aviation:
 - Carbon neutral growth by 2020 compared to 2005
 - Absolute reduction of significant air quality impacts, notwithstanding aviation growth
 - 1 billion gallons of renewable jet fuel in use by aviation by 2018



U.S. Climate Action Plan for Aviation

The U.S. is pursuing a multipronged approach to address greenhouse gas emissions from aviation

- Aircraft and engine technology improvement
- Operational improvements
- Alternative fuels development and deployment
- Policies, environmental standards, and market based measures
- Scientific understanding through research, modeling and analysis



Alternative Fuels Principles – U.S. Vision

- **Alternative Jet Fuels must be drop in, have equivalent safety and better environmental performance than petroleum Jet fuel**
- **Enable all possible fuels that meet criteria**
- **Government role to address key barriers**
- **Work through Public-Private Partnerships**
- **Address the whole supply chain**
- **Leverage expertise and resources of other government agencies and other countries**
- **Aviation should be a lead user of alternative fuels**



FAA Programs supporting Alternative Jet Fuels



Aviation Sustainability Center (ASCENT)

- Center of Excellence for Alternative Jet Fuels and Environment



Continuous Lower Energy, Emissions and Noise (CLEEN)

- Reduce aircraft fuel burn, emissions and noise through technology & advance alternative jet fuels



Commercial Aviation Alternative Fuels Initiative (CAAIFI)

- Public-Private coalition for commercial aviation to engage the emerging alternative fuels industry



Continuous Lower Energy, Emissions and Noise (CLEEN) Program



- **FAA R&D Program:**
 - Reduce aircraft fuel burn, emissions and noise through technology & advance alternative jet fuels
 - 1:1 minimum cost share requirement
- **CLEEN I: 2010-2015 (\$125M FAA Funding)**
 - Alternative Jet Fuel Projects with Boeing, Rolls Royce, Pratt & Whitney, and Honeywell
- **CLEEN II: 2015-2020 (\$100M FAA Funding)**
 - Industry Day - December 3, 2013 in Washington DC
 - Solicitation open until February 2, 2015
 - More information available at:
<https://faaco.faa.gov/index.cfm/announcement/view/18077>



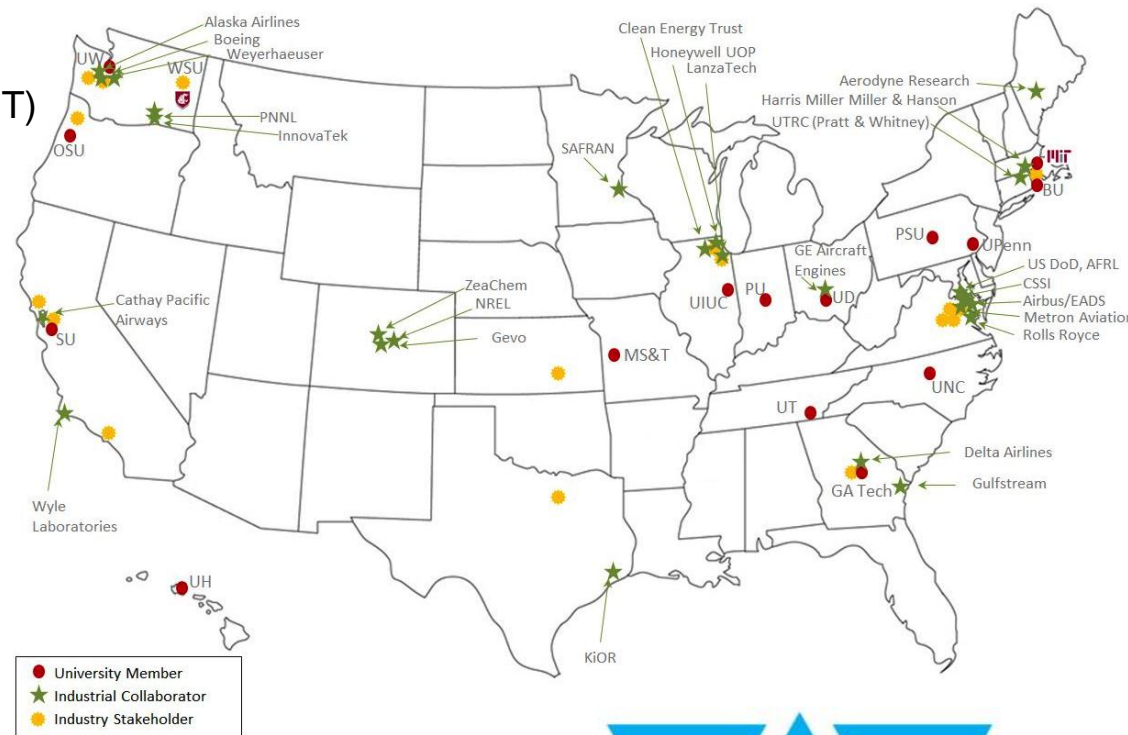
FAA CENTER OF EXCELLENCE FOR ALTERNATIVE JET FUELS & ENVIRONMENT

Lead Universities:

- Washington State University (WSU)*
- Massachusetts Institute of Technology (MIT)

Core Universities:

- Boston University (BU)
- Georgia Institute of Technology (Ga Tech)
- Missouri University of Science and Technology (MS&T)
- Oregon State University (OSU)*
- Pennsylvania State University (PSU)*
- Purdue University (PU)*
- Stanford University (SU)
- University of Dayton (UD)
- University of Hawaii (UH)*
- University of Illinois at Urbana-Champaign (UIUC)*
- University of North Carolina at Chapel Hill (UNC)
- University of Pennsylvania (UPenn)
- University of Tennessee (UT)*
- University of Washington (UW)*



* Denotes USDA NIFA AFRI-CAP Leads and Participants & Sun Grant Schools

FAA Alternative Jet Fuel Activities

- **Testing**

- Support Cert/Qual testing
- Improve Cert/Qual process
- Emissions measurements

- **Analysis**

- Environmental sustainability
- Techno-economic analysis
- Future scenarios

- **Coordination**

- Interagency
- Public-Private
- State & Regional
- International



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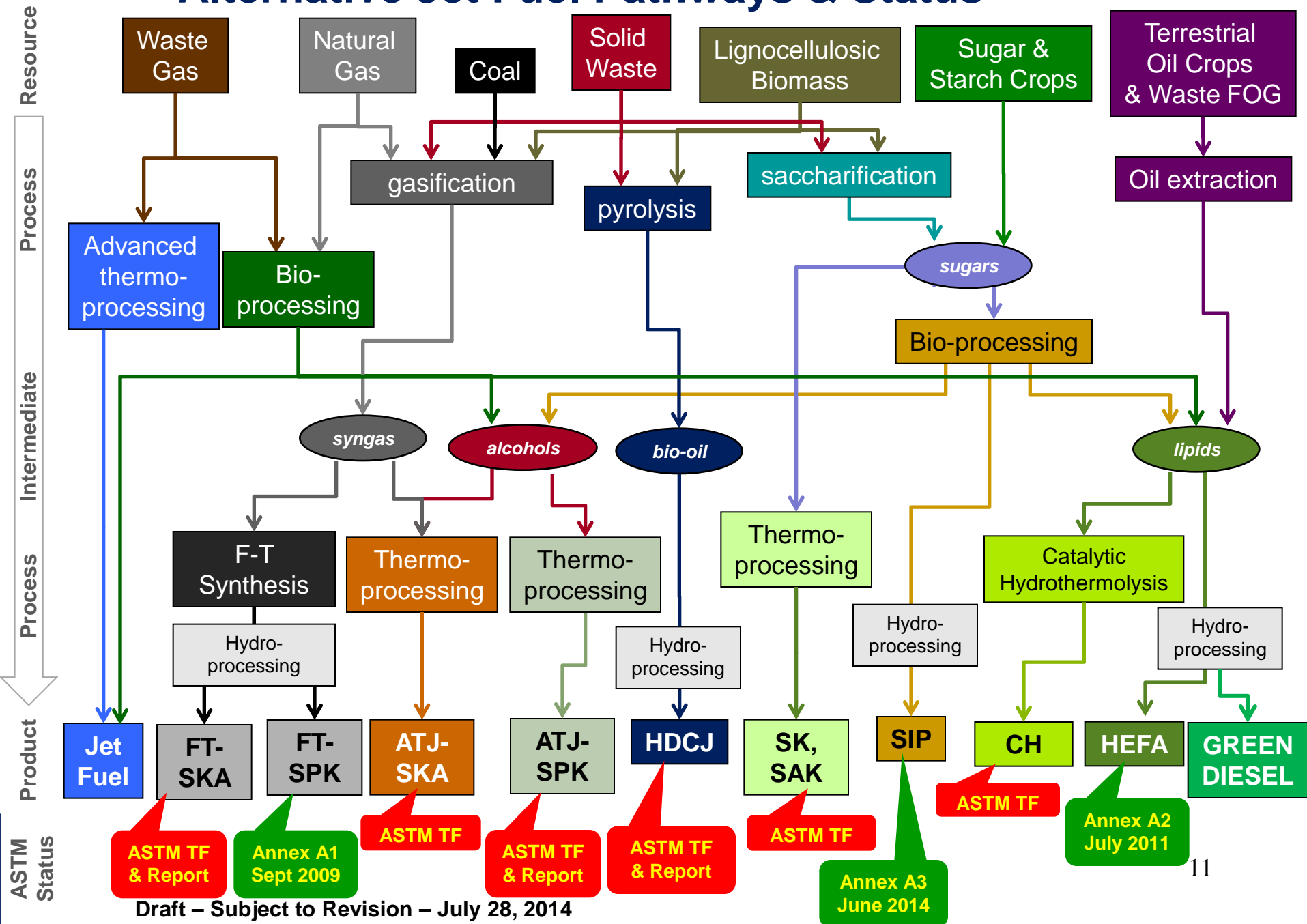
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Alternative Jet Fuel Pathways & Status

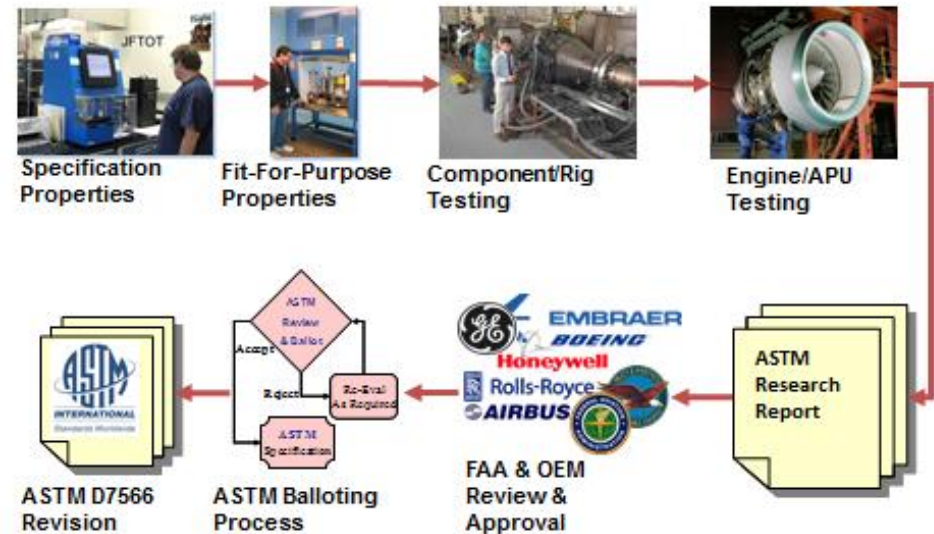


Fuel Qualification Support

Support ASTM Intl evaluation of alternative jet fuels

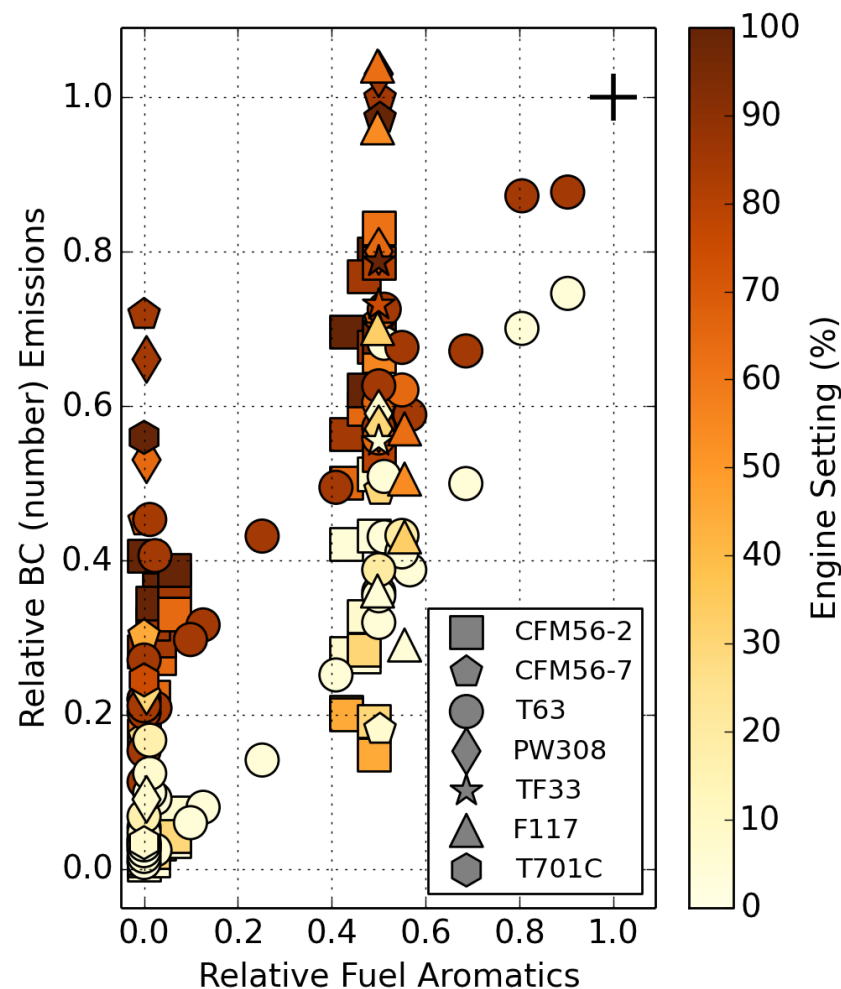
- Support ASTM D4054 testing activities to enable development of data for fuel approval
- ASTM Research Report Review
- Streamline ASTM Intl jet fuel approval process via the National Jet Fuel Combustion Program

Aviation Fuel Qualification (ASTM D4054 Process)



Emissions Measurements

- Supporting teams at Stanford and ARI to examine ACCESS results as well as MIT and PSU to examine test data to understand how fuel composition effects emissions
- PARTNER developing relationship for black carbon emissions based on engine thrust and fuel aromatic content¹
- Expanding knowledge to include alt jet fuels that have aromatic content (e.g., HDCJ)



Preliminary PARTNER Project 47 research results
(<http://partner.aero>) – **DO NOT CITE OR QUOTE**



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Environmental Analyses

- Environmental analyses

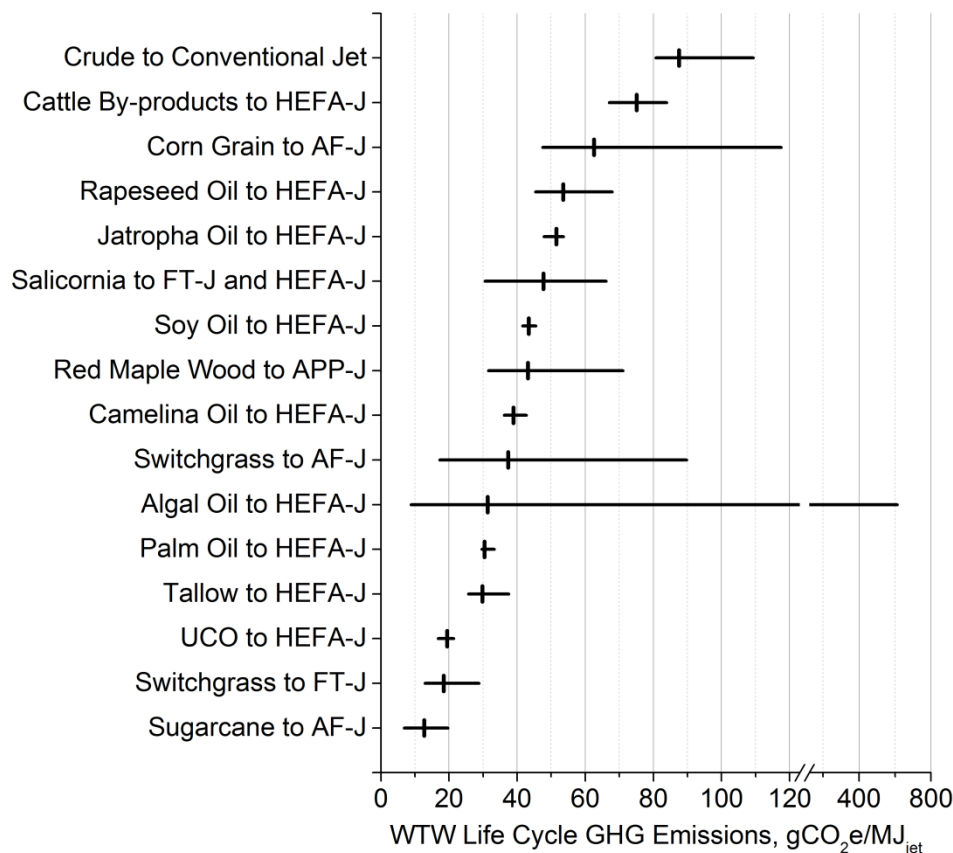
- Focus on well-to-wake (WTW) life cycle GHG emissions
- Results incorporated into ANL GREET model¹ and EPA analysis
- Examining climate impacts from change in combustion emissions

- Recent life cycle GHG work²

- Tallow and waste oils for HEFA
- Advanced fermentation of sugars, starches, and switchgrass

- Water footprint analysis³

- Examined water footprint of all fuels considered for LC GHG emissions
- Fuel use on same order of magnitude as conventional jet fuel unless irrigation is used



1. ANL GREET model available at <http://greet.es.anl.gov/files/aviation-lca>
2. PARTNER Project 28 and 47 research: (partner.aero): Stratton et al. 2010, Staples et al. 2014, Bond et al. 2014, and Seber et al. (forthcoming)
3. PARTNER Project 47 (partner.aero): Staples et al. 2013



Economic Analyses

- Techno-Economic Analysis
 - Computing minimum selling price (MSP) for n^{th} plant
 - Using discounted cash flow rate of return method
- Effort is focused on identifying ways to reduce production costs
- Lower feedstock costs
 - HEFA production from rotation crop such as pennycress¹
 - Advanced fermentation using sugar cane²
- Modify product slate
 - For HEFA, maximizing jet fuel production requires \$0.25 to \$0.30 per gallon more than maximizing diesel fuel to break even³
 - Maximizing biochemicals makes certain jet fuel production pathways economical⁴
- Utilizing brownfield facilities reduces production costs^{2,3}

Research results can be found at <http://partner.aero/>:

1. Project 31 – Winchester et al. 2013
2. Project 47 – Staples et al. 2014
3. Project 28 – Pearson et al. 2013
4. Project 47 – Bond et al. 2014



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ASCENT Alternative Jet Fuel Supply Chain Project

- **Examine the barriers to the large scale production of alternative jet fuels via the full range of pathways being considered for ASTM approval**
- **Considering the entire supply chain:**
 - feedstock production, transportation, and conversion
 - jet fuel and co-products,
 - blending and jet fuel use by aviation
 - quantify competition for resources along the supply-chain by other sectors
- **Considering Project Contributions**
 - Aimed at a holistic evaluation of pathways and resources
 - Incorporate social, economic, and environmental considerations
 - In context of current policy environment



Research Team

- **ASCENT Universities:**
 - Washington State (M. Wolcott)
 - Penn State (P. Smith)
 - U. Illinois (J. Endres)
 - U. Tennessee (T. Rials)
 - Penn State (T. Richard)
 - MIT (R. Malina)
 - Purdue (W. Tyner)
- **National Labs:**
 - DOT Volpe Center
 - Argonne National Lab
- **Cost share support:**
 - Biojet Canada (TC funded effort)
 - ITAKA (CLH Aviation, EC funded effort)
 - Delta Airlines
 - Byogy
 - Monsanto
- **Universities represented:**
 - USDA AFRI Coordinated Agricultural Projects
 - Northwest Advanced Renewables Alliance (NARA via WSU)
 - Southeast Partnership for Integrated Biomass Supply Systems (IBSS via U. Tennessee)
 - Northeast Woody/Warm-season Biomass Consortium (NEWBio via PSU)
 - Sun Grant Partnership
 - Bioenergy Science Center (via U. Illinois)



Objectives

1. Develop information on regional supply chains

- Scenarios of future alternative jet fuel production
- Outputs will be used as inputs to a regional supply chain analysis tool (AFTOT) being developed by the Volpe Center

2. Identify the key barriers in regional supply chains that must be overcome

- to produce 1 billion gallons of alternative jet fuel by 2018 and
- an order of magnitude larger production in the longer term

3. Support International Civil Aviation Organization (ICAO) Committee on Aviation Environmental Protection (CAEP) Alternative Fuel Task Force (AFTF)



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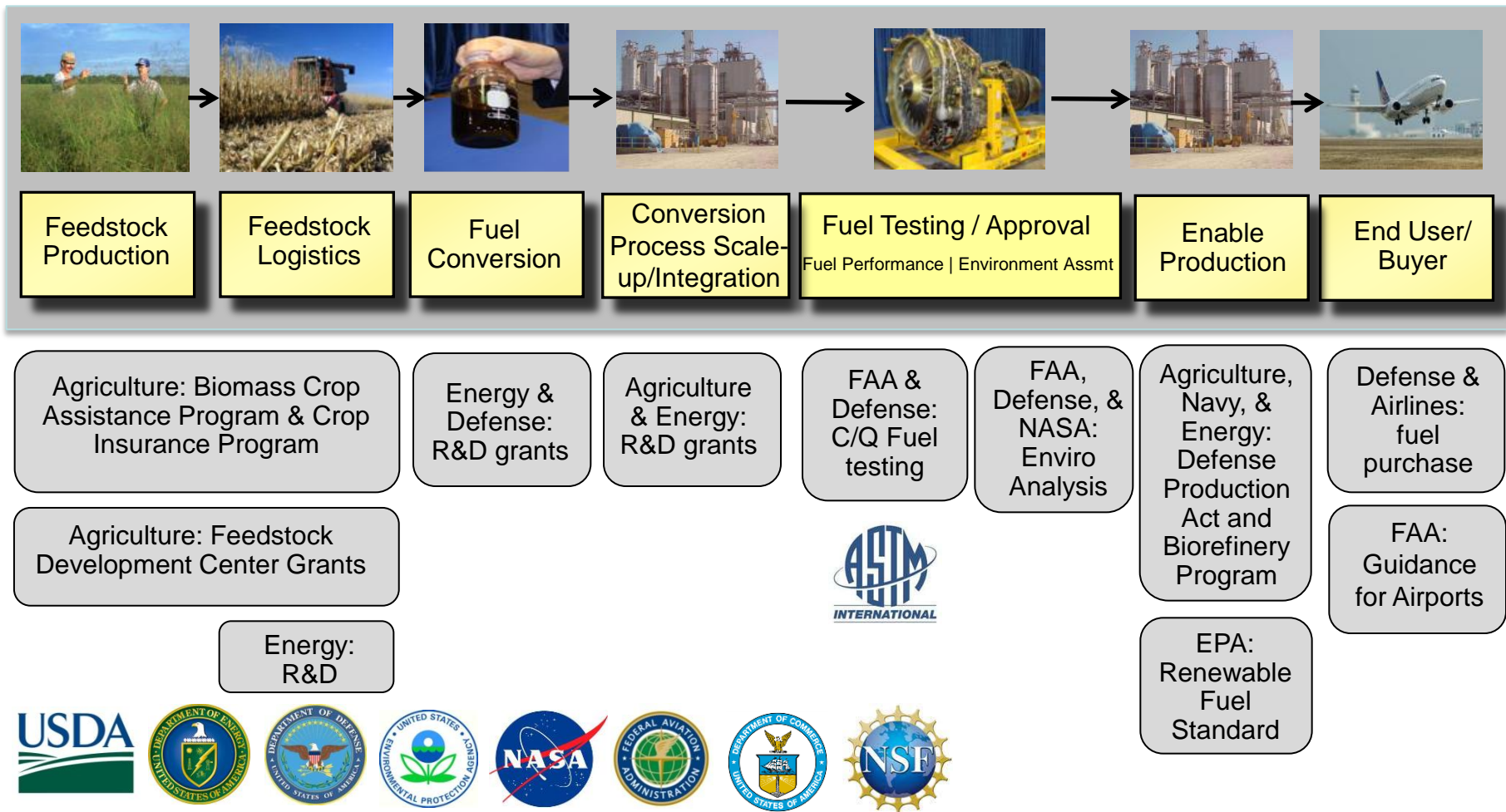


Commercial Aviation Alternative Fuels Initiative (CAAFI)

- Public-Private coalition for commercial aviation to engage the emerging alternative fuels industry
- Enable development of alt jet fuels:
 - Equivalent safety/performance (drop-in)
 - Comparable cost
 - Environmental improvement
 - Security of Energy supply
- Four teams for key issues:
 - Environment Team
 - Certification-Qualification Team
 - R&D Team
 - Business Team
- State and Regional Support
- International Cooperation



Coordinate USG Efforts Across the Supply Chain



National Alternative Jet Fuels (AJF) R&D Strategy (in development)

Intended Purpose

Identify opportunities and strategically address challenges associated with Research, Development, Demonstration, and Deployment (RD3) along the development path of alternative jet fuels.

R&D Goals & Objectives

- Feedstock Development, Production, and Logistics
- Fuel Conversion and Scale-Up
- Fuel Testing and Evaluation
- Integrated Challenges

An undertaking by Aeronautical Science and Technology Subcommittee of the OSTP/NSTC with input from stakeholder community.

8 participating Departments & Agencies: USDA, DOC, DOD, NASA, FAA, DOE, EPA, NSF, DOS



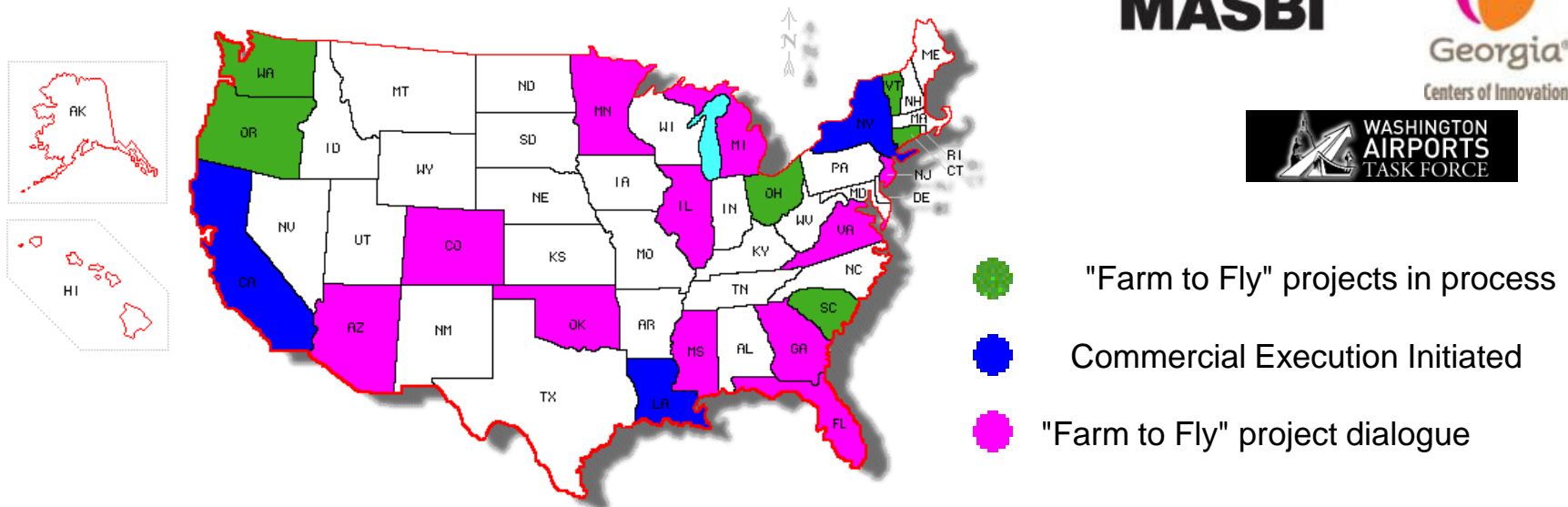
Farm to Fly 2.0

... “THEREFORE, AS OUR GOAL, we the undersigned, jointly signify our intent to continue working together over the next five years in an expanded collaboration entitled “Farm to Fly 2.0”, to **enable commercially viable, sustainable bio-Jet Fuel supply chains in the U.S.** that are able to support the goal of **one billion gallons of bio-Jet Fuel production** capacity and use for the Aviation Enterprise **by 2018**”



CAAFI State & Regional Deployment

- Working with local lead organizations/POCs
- Provide context, advice, strategy, benchmarking
- Facilitate networks & links between stakeholders
- Link to Farm to Fly 2.0



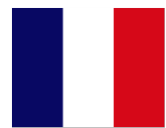
* Does not include Dept. of Energy Pilot Projects, Defense Production Act Projects, map credit to diymaps.net.



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International Engagement

- Bilateral Cooperation Agreements
- Informal coordination with counterpart organizations
- International Civil Aviation Organization



Summary

- Alternative jet fuels are a key component of U.S. strategy for meeting aviation environmental goals
- FAA efforts are directed to overcoming key challenges via testing, analysis and coordination
- Multiple programs and activities focus on different aspects of the challenge
- Partnerships across technical areas are a key focus
- Strong domestic and international coordination necessary for success





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